

**CLAIMS**

1        1. A method for simulating film grain comprising the steps of:  
2            receiving image information representative of an image from which film grain has  
3        been at least attenuated;  
4            receiving film grain information that includes at least one parameter among a set  
5        of possible parameters specifying different attributes of the film grain previously in the  
6        image;  
7            selecting a model for simulating grain;  
8            simulating the film grain in accordance with the selected model and the at least  
9        one parameter; and  
10          merging the simulated film grain into the image.

1        2. The method according to claim 1 wherein the set of parameters e includes  
2        a plurality of correlation parameters and a plurality of intensity-independent parameters.

1        3. The method according to claim 2 wherein at least one correlation  
2        parameter defines a spatial correlation in a perceived pattern of film grain.

1        4. The method according to claim 2 wherein at least one correlation  
2        parameter defines a correlation between color layers.

1        5. The method according to claim 2 wherein at least one correlation  
2        parameter defines a temporal correlation resulting from previous processing the image  
3        sequence.

1        6. The method according to claim 2 wherein at least one intensity-  
2        independent parameters defines an aspect ratio of the film grain.

1        7. The method according to claim 1 wherein at least one parameter defines  
2        intensity of a random component of the film grain.

1           8.     The method according to claim 2 wherein at least one of the intensity-  
2 independent parameters defines a color space and blending mode operation used to  
3 merge the simulated film grain with the image.

1           9.     The method according to claim 1 wherein the message containing the film  
2 grain information is transmitted out-of band with the image representative information.

1           10.    The method according to claim 1 wherein the message containing the film  
2 grain information is transmitted in band with the image representative information.

1           11.    The method in accordance with claim 2 where the set of parameters are  
2 computed in accordance with a second order auto regression representation of the  
3 spatial correlation and a first order regression representation of the cross-color and  
4 temporal correlations.

1           12.    The method according to claim 3 wherein the at least one parameter  
2 describing the spatial pattern of the grain is established in accordance with a spatial  
3 convolution model.

1           13.    The method according to claim 3 wherein the at least one parameter  
2 describing the spatial pattern of the grain is obtained from cut frequencies of a filter in  
3 the Fourier domain.

1           14.    The method according to claim 1 wherein the set of selecting the model  
2 further comprises the step of selecting an additive grain model.

1           15.    The method according to claim 1 wherein the set of selecting the model  
2 further comprises the step of selecting a multiplicative grain model.

1        16. The method according to claim 1 wherein the step of selecting the model  
2 further comprises the step of selecting a model that simulates the film grain by  
3 convolving a set of random numbers by a linear, time-invariant, digital-filter  $h$  defined in  
4 the form of:

$$h = (h_0, h_1, h_2, h_3, \dots h_n)$$

6 wherein the set of parameters includes filter coefficients.

1        17. The method according to claim 1 wherein the step of selecting the model  
2 further comprises the step of multiplying in the frequency domain by a Fourier Transform  
3 of an impulse response  $H$  and a Fourier Transform set of random numbers to yield a  
4 simulated grain result  $Y(u)$  in accordance with the relationship

$$Y(u) = X(u) \cdot H(u)$$

1           18. Apparatus for simulating film grain, comprising :

first means for: (1) receiving image information representing an image from which film grain has been substantially attenuated; (2) receiving film grain information that includes at least one parameter among a set of possible parameters specifying different attributes of the film grain; (3) selecting a model for simulating grain; and (4) simulating the film grain in accordance with the selected model and the at least one parameter; and

second means for merging the simulated film grain with the image .

1           19. The apparatus according to claim 18 wherein the model selected by the  
2 first means comprises an additive grain model.

1        20. The apparatus according to claim 18 wherein the model selected by the  
2 first means comprises a multiplicative grain model.

1           21. The apparatus according to claim 18 wherein the model selected by the  
2 first means simulates the film grain by convolving a set of random numbers x by a linear,  
3 time-invariant, digital-filter h defined in the form of:

$$h = (h_0, h_1, h_2, h_3, \dots h_n)$$

5 wherein the set of parameters includes filter coefficients.

1           22. The apparatus according to claim 18 wherein the model selected by the first  
2 means simulates film grain by multiplying in the frequency domain by a Fourier  
3 Transform of an impulse response H and a Fourier Transform set of random numbers to  
4 yield a simulated grain result Y(u) in accordance with the relationship:

$$Y(u) = X(u) \cdot H(u).$$